PCT/IL- 0 3 / 0 0 0 0 4

Rec'd PCT/PTO 05 APR 2005

REC'D 29 DEC 2003

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152628	מספר: Number
04 -11- 2002	תאריך: Date
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חוק הפטנטים, התשכ"ז-1967
PATENTS LAW, 5727-1967

בקשה לפטנט
PATENT APPLICATION

אני, (שם המבקש, מענו - ולגבי גוף מאוגד - מקום התאגדותו)
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(בעברית) מכלול צילום כלל כיווני
(Hebrew)

(באנגלית) Omni-Directional Imaging Assembly
(English)

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מבקשת פטנט from application No_____ מס' dated_____ מיום	לבקשה/לפטנט to Patent/Appl. No_____ מס' dated_____ מיום	מספר/סימן Number/Mark	תאריך Date	מדינת האיגוד Convention Country
*יפוי כח: ~~כללי/מיוחד - רצוף בזה~~ / עוד יוגש P.O.A.: ~~general / specific - attached~~ / to be filed later- Has been filed in case_____ הוגש בענין				
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OMNI-DIRECTIONAL IMAGING ASSEMBLY

מכלול צילום כלל כיווני

Field of the Invention

The present invention relates to the field of extremely wide angle imaging. More specifically, it relates to optical structures that enable the coverage of a panoramic or nearly spherical field of view, suitable for video or still imaging.

Background of the Invention

Imaging of a large field of view has many applications in the fields of defense, security, monitoring, entertainment, industry, medical imaging and many other fields. Imaging of a panoramic or nearly spherical field of view, using a single image capture device, is especially applicable for a variety of needs due to their relative simplicity, low-cost and miniaturization possibilities.

Prior art techniques of panoramic imaging make use of several image capture devices, each one aimed at a different sector limited in width, combined in a manner that all of them together, when properly aligned, cover a full 360 degrees field of view. Another prior art method for panoramic imaging relies on a single image capture device, rotated around a vertical axis. In this method the image capturing device covers a limited sector at any single moment, but while completing a full rotation, it creates a sequence of images which are combined together to a panoramic image.

The main disadvantage of the prior art methods is their relative complexity. Some prior art methods necessitate moving/rotating mechanisms, require frequent alignment and very often turn out to be maintenance-intensive.

A different prior art approach makes use of axis-symmetric reflective surfaces, used to reflect an omni-directional field of view towards a single image-capture device. In this approach a circular image is formed on the focal plane array of the image capture device. The shape of the image derives from the reflection of the surrounding field of view by the reflective surface, and often includes aberrations. The image shape and additional aberrations are corrected by image processing techniques. A sub-group of the said technique makes use of two reflective surfaces designed to doubly reflect the omni-directional field of view towards the image capture device. Such a design is described in US 6,426,774. In the said patent, a convex axis-symmetric reflective surface reflects a cylindrical field of view towards a flat reflective surface located coaxially with it. A circular image is reflected from the convex axis-symmetric surface towards the flat reflective surface and then reflected towards an image capture device, which is located at the concave side of the convex reflective surface, through a hole located at the center of the axis-symmetric convex reflective surface.

Additional methods were developed to achieve capture of an enlarged field of view of an almost spherical scene. Such a design is described in WO02/059676, incorporated herein

by reference. In the said publication, two reflective surfaces are used, in both of which a transparent area is formed at the center to enable penetration of beams originating at an additional scene, which is not covered by the reflective surfaces. As a result of the unique design, a nearly spherical field of view is captured, comprising a cylindrical field of view doubly reflected by the reflective surfaces towards the image capture device, and an additional field of view penetrating through the said transparent areas towards the image capture device. The said transparent areas may be fabricated either as transparent surfaces or as optical lenses which enhance the properties of the additional scene.

The mentioned prior art techniques represent methods of acquiring a large field of view, using optical structures which comprise several separate optical components.

As will be described in detail below, the present invention enables coverage of a panoramic or nearly spherical field of view by utilizing unique, aspheric monolithic optical block, which incorporates all refractive and reflective surfaces needed to acquire the scene. As a result of the unique aspheric shape of the optical block and its surfaces, aberrations are reduced to an acceptable level and generally save the need of additional correction lenses along the optical path, thus simplifying the optical design and structure and reducing production costs.

SUMMARY OF THE INVENTION

According to a first preferred embodiment of the present invention there is provided an imaging assembly capable of imaging a full 360 degrees panoramic field of view. The panoramic imaging assembly comprises an aspheric optical block, the optical design of which dictates the exact shape, curves and the vertical field of view that it covers. The aspheric optical block comprises a vertical axis of symmetry, a transparent upper surface, completely coated with reflective material from its exterior, a transparent perimeter surface, a transparent lower convex surface coated with reflective material from its exterior and a transparent circular surface maintained in the center of said lower convex surface around said vertical axis of symmetry. Any light ray originating within the field of view, which is covered by the aspheric optical block, will be refracted by the transparent perimeter surface of the aspheric optical block. The ray will then travel within the aspheric optical block and be reflected by the reflective material that coats the exterior of the transparent lower convex surface. The ray will be reflected towards the upper surface where it will be reflected towards the transparent circular surface. The ray will then be refracted by said transparent circular surface and will exit the optical block.

Preferably, the panoramic imaging assembly will further comprise an image capture device located coaxially with the aspheric optical block, directed towards the transparent circular surface, the purpose of which is to capture the image that is reflected from the aspheric optical block.

Preferably, but non limitatively, the image capture device is equipped with its own focusing lens, set to focus on the image that is reflected by the aspheric optical block.

Still preferably, the panoramic imaging assembly further comprises a connector located between said aspheric optical block and said image capture device, having a first edge and a second edge. The area between the two edges is optically transparent to enable light rays penetrating from the first edge, to arrive and exit through the second edge without distortion.

The shape of the said connector is preferably cylindrical.

According to a preferred embodiment of the invention, the first edge of the connector is designed to attach to the aspheric optical block. According to another preferred embodiment of the invention, the second edge of the connector is designed to be mounted on and attached to the said image capture device, thus fastening and fixating the distance and relation between the aspheric optical block and the image capture device.

According to yet another preferred embodiment of the invention, the distance between the two edges of the connector is designed to allow optimal focus on the image that is reflected from the aspheric optical block by the image capture device. The said distance is

determined by the optical design and takes into account the characteristics of the aspheric optical block and of the image capture device.

The said connector may be fabricated together with the aspheric optical block, of the same material, to form a single monolithic optical structure designed for mounting on the image capture device.

According to a preferred embodiment of the invention, the said panoramic imaging assembly may further comprise an optical lens designed to correct astigmatism in the image that is reflected by the said aspheric optical block. The said optical lens is located around said vertical axis of symmetry and between said image capture device and said aspheric optical block.

Preferably, the said transparent circular surface is fabricated as a refractive lens, having a different geometry than the lower convex surface.

According to another preferred embodiment of the present invention there is provided an imaging assembly capable of imaging simultaneously a first scene of full 360 degrees panoramic field of view together with a second scene which is located at least partially above the first scene, thus enabling coverage of a nearly spherical field of view. The meaning of the term "above", as used herein and as applied to a "scene", is apparent to

persons skilled in the art, and will be further understood by the description of preferred embodiments of the invention provided hereinafter.

The nearly spherical view imaging assembly comprises an aspheric optical block, the optical design of which dictates the exact shape and curves. The optical design also determines the sizes of the fields of view that are covered by the aspheric optical block. The aspheric optical block comprises a vertical axis of symmetry, a transparent upper surface partly coated with reflective material from its exterior. A transparent area is maintained in said upper surface around said vertical axis of symmetry. The aspheric optical block further comprises a transparent perimeter surface and a transparent lower convex surface partly coated with reflective material from its exterior. A transparent circular surface is maintained in the said lower convex surface around said vertical axis of symmetry.

Any light ray originating at a first panoramic scene, which is within the field of view that is covered by the lower convex surface, will be refracted by the transparent perimeter surface of the aspheric optical block. The ray will then travel within the aspheric optical block and be reflected by the reflective material that coats the exterior of the transparent lower convex surface. The ray will be reflected towards the upper surface where it will hit and be reflected again towards the transparent circular surface. The ray will then be refracted by the said transparent circular surface and will exit the optical block. Any light ray originating at the second scene will be refracted by the transparent area, travel

through the aspheric optical block and be refracted by the transparent circular surface and exit the aspheric optical block. Light rays originating at the said first scene and at the said second scene will together provide coverage of a nearly spherical field of view.

The transparent area may be fabricated as a refractive lens as part of the aspheric optical block having different geometry than the upper surface. For instance, it may be fabricated as a hole formed around said vertical axis of symmetry, extending form the upper surface of the aspheric optical block to the transparent circular surface of the aspheric optical block.

The nearly spherical view imaging assembly may further comprise an optical structure located coaxially with the said axis of symmetry of the aspheric optical block and above the said transparent area. The said optical structure is designed to refract light rays originating at the said second scene towards the said transparent area.

The optical structure may comprise a plurality of optical elements.

Preferably (but not limitatively), the nearly spherical view imaging assembly will further comprise an image capture device located coaxially with the aspheric optical block, directed towards the transparent circular surface.

Still preferably, the image capture device is equipped with its own focusing lens, set to focus on the image that arrives from the direction of the aspheric optical block.

The nearly spherical view imaging assembly will preferably further comprise a connector located between said aspheric optical block and said image capture device, having a first edge and a second edge. The area between the two edges is optically transparent to enable light rays penetrating from the first edge, to arrive and exit through the second edge without distortion.

The shape of the said connector is preferably cylindrical.

According to a preferred embodiment of the invention, the first edge of the connector is designed to be attached to the aspheric optical block. According to another preferred embodiment of the invention, the second edge of the connector is designed to be mounted on and attached to the image capture device, thus fastening and fixating the distance and relation between the aspheric optical block and the image capture device.

In a preferred embodiment of the invention, the distance between the two edges of the connector is designed to allow optimal focus on the image that arrives from the aspheric optical block by the image capture device. Said distance is determined by the optical

design and takes into account the characteristics of the aspheric optical block and of the image capture device.

The connector may be fabricated together with the aspheric optical block, and can be made of the same material, to form a single monolithic optical structure designed for mounting on the image capture device.

According to a preferred embodiment of the invention, the said nearly spherical view imaging assembly may further comprise an optical lens designed to correct astigmatism in the image that is reflected by the said aspheric optical block. The said optical lens is located around said vertical axis of symmetry and between said image capture device and said aspheric optical block.

Preferably, the said transparent circular surface is fabricated as a refractive lens, having a different geometry than the lower convex surface

Brief Description of the Drawings

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, purely by way of example, to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of

preferred embodiments of the present invention only. No attempt is made to show in the drawings structural details of the invention in greater detail than is necessary for understanding of the invention. Details not shown in the figures are readily understood by the skilled person who will easily appreciate how the several forms of the invention may be carried out.

In the drawings:

Fig. 1 is a schematic description of an aspheric optical block, which enables the coverage of a panoramic field of view, and a scheme of an optical path of a light ray, originating from the panoramic field of view;

Fig. 2 is a schematic description of an imaging assembly, which utilizes the aspheric optical block to capture an image of a 360 degrees panoramic field of view;

Fig. 3 is a schematic description of the image shape as acquired by the image capture device;

Fig. 4 is a schematic description of an aspheric optical block with additional features that enable the coverage of a 360 degrees panoramic field of view and an additional upper sector, and a scheme of optical paths of light rays that originate at the different sectors;

Detailed Description of the Invention

A first embodiment of the present invention provides a panoramic imaging assembly based on an aspheric optical block. The aspheric optical block is designed to collect light rays from a surrounding 360 degrees field of view and reflect them towards an image capture device located coaxially with it. The aspheric optical block is designed to have a transparent upper surface completely coated with reflective material from its exterior, a perimeter aspheric transparent surface and a lower convex transparent surface, coated with reflective material from its exterior. A transparent circular surface is maintained at the center of the lower convex transparent surface. Those skilled in the art will appreciate that the exact structure of the aspheric optical block and the exact formulas describing its curves are subject to precise optical design, well within the scope of the routineer. Proper optical design will preserve maximum quality of the image that is refracted and reflected by the aspheric optical block. It is further noted that the coverage range of the vertical field of view is also subject to the optical design and can be controlled by the optical design. The optical design also dictates the required distance between the aspheric optical block and the image capture device to ensure optimal focus by the image capture device on the image that is reflected from the aspheric optical block.

Fig. 1 is a schematic description of a monolithic aspheric optical block designed for coverage of 360 degrees panoramic surroundings. The aspheric optical lens (1) is fabricated as a single solid optical element comprising a transparent perimeter surface (2),

a transparent upper surface (3), a transparent lower convex surface (4) and a circular transparent surface (5) located at the center of the lower convex surface (4). The transparent lower convex surface (4) is coated with reflective material from its exterior, designed to reflect light rays, which originate at a 360 degrees surroundings (6), towards the upper surface (3). The upper surface (3) is coated with reflective material from its exterior designed to reflect light rays, which arrive from the direction of the lower convex surface (4), towards the circular transparent surface (5) and from there to an image capture device (not shown) located at the concave side of the lower convex surface (4). It is stressed that the circular transparent surface (5) may be fabricated in a different geometry than that of the lower convex surface (4) with the purpose of correcting some of the aberrations that may occur as a result of the reflections and refractions of rays inside the lens (1). It is further stressed that the curvature of the upper surface (3) may be designed in several ways to control the quality of the image that is reflected by the optical lens (1) and to aid in the ability of the image capture device to acquire an image with minimal aberrations and maximum focus. Those skilled in the are would appreciate that the perimeter surface (2), the lower convex surface (4), the upper surface (3) and the transparent circular surface (5) are all designed and determined with mutual consideration of each other's affects on the rays the penetrate the lens (1). Proper optical design will achieve both coverage of a vertical field of view as required by the application, along with control over the level of aberration and astigmatism of the image that is reflected by the optical lens (1).

Reference is now made to the optical paths of light rays originating at a 360 degrees surrounding (6) and located within the vertical field of view of the optical lens (1).

A light ray (7) represents a group of light rays originating at the field of view (6) that is covered by the optical lens (1). The light ray (7) hits the perimeter refractive surface (2) at a first point (8) where it is refracted and penetrates the optical lens (1). It then travels through the optical lens (1) and hits the lower surface (4) at a second point (9), where it is reflected towards the upper surface (3). The reflection is achieved due to the existence of the reflective material on the exterior of the lower transparent surface (4). After hitting the lower surface (4) at the second point (9), the first light ray (7) travels through the optical lens (1) and hits the upper surface (3) at a third point (10). When hitting the upper surface (3), the first light ray (7) is reflected towards the circular transparent area (5), and hits the circular area (5) at a fourth point (11), where it is refracted and exits the lens towards the image capture device (not shown). The reflection of the ray from the upper surface (3) is achieved due to the existence of the reflective coating on the exterior of the upper surface (3). Similar paths can be described in reference to any other light ray originating within the field of view (6), which is covered by the lens (1). It is stressed that each light ray originating from a different angle will hit different points of the aspheric optical lens, and will naturally have different optical paths.

Fig. 2 illustrates an entire imaging assembly, which utilizes the aspheric optical block described in Fig. 1, to enable the capture of a 360 degrees panoramic image. The imaging

assembly comprises the optical block (1) and an image capture device (12). The image capture device (12) is directed towards the transparent circular surface (5), designed to capture the image that is doubly reflected from the upper surface (3) and refracted by the transparent surface (5). The optical axis of the image capture device (12) preferably coincides with the axis of symmetry of the axis-symmetric aspheric optical lens (1). The distance between the image capture device (12) and the optical lens (1) is determined according to the parameters of the optical design, with the purpose to ensure maximum focus by the image capture device (12) on the image that arrives from the direction of the optical lens (1). To ensure a fixed distance between the image capture device (12) and the optical lens (1), the lens (1) may be fabricated together with an attachment area (13), designed for direct mount on the image capture device (12). In some cases, when a larger distance is required between the lens (1) and the image capture device (12), a connector (not shown) may be incorporated between the two said elements, connected at one end to the attachment area (13) of the lens (1) and at its second end to the image capture device (12). It is stressed that the length of the connector is designed with accordance to the optical design, to ensure optimal focus by the image capture device (12) on the image that arrives from the direction of the lens (1). It is further stressed that the connector may be fabricated as a continuation of the optical block, thus forming a single monolithic optical structure designed for direct mount on an image capture device (12). The image capture device (12) is preferably equipped with its own focusing lens (14), which is set to focus the image that should be captured by the image capture device (12). Those skilled in the

art would appreciate that the focusing lens is chosen and adjusted in accordance with the distance between the image capture device (12) and the optical block (1), and according to specifications of the optical design. As previously noted, the distance between the image capture device (12) and the optical block (1) is determined by the optical design to ensure both optimal focus of the image and preferably that the entire image that is reflected by the optical block (1) and no more than that image, is captured by the image capture device (12), to allow optimal image resolution. For some applications, which may require improved image quality, additional lens (not shown) may be incorporated in between the focusing lens (14) and the optical block (1), designed to correct astigmatism of the image prior to its capture by the image capture device (12). It is stressed, however, that proper optical design of the optical block (1) will reduce such astigmatism to a tolerable level suitable for most applications, and that generally additional optical elements, other than the optical block (1) and the focusing lens (14), are not required. The setting as described hereby will result in acquiring an image of a circular shape, which is actually the reflection of the panoramic surroundings, as further described in reference to Fig. 3.

Fig. 3 is a schematic description of the shape of the image that is acquired by the image capture device. As described with reference to Fig. 2, the image capture device captures an image, which is the reflection of the panoramic scene. In Fig. 3, an image (15) is acquired by the image capture device. The image (15) contains a first area (16), which is

the reflection of the panoramic view and a second area (17) which is the reflection of the image capture device itself. Every light ray, which originates at the panoramic surrounding at an elevation angle which is covered by the optical block, will appear at the first area (16) of the image (15). It is stressed that the image shape as indicated, describes an image as it is acquired by the image capture device in a preferable case when the lens of the image capture device is set to capture all and no more than the reflection, and the reflection appears at the center of the image. The circular shape of the image, although suitable for some needs, may be considered unsuitable for standard viewing. Therefore the image is usually corrected by image processing software, designed specifically according to the parameters of the optical block. Such operation of the software corrects the image shape and transforms it to another shape, preferably rectangular, more suitable for viewing. It is stressed that by using the imaging assembly described by figure 2, the central sector (17) of the image (15) will comprise the reflection of the image capture device. Having this area of the image being actually "wasted", it may be manipulated by advanced optical designs to comprise an image of a second scene, at least partially different from the panoramic scene that appears in the outer sector (16) of the image. An example of such advanced design is described in reference to a second embodiment of the present invention in Fig. 4.

The second preferred embodiment of the present invention provides an imaging assembly capable of capturing a first scene of 360 degrees panoramic surroundings and a second

scene, located at least partially above the first scene. The image capture is achieved using a unique aspheric optical structure and a single image capture device. The aspheric optical structure has several possible designs as will be described by the following figure. Those skilled in the art would appreciate that the exact structure of the aspheric optical structure and the exact formulas describing its curves or optical qualities of its surfaces are subject to precise optical design. Proper optical design will preserve maximum quality of the image that is acquired by the image capture device. It is further noted that the coverage ranges of the different scenes are also subject to the optical design and can be controlled by the optical design. Optical design also dictates the required distance between the aspheric optical block and the image capture device to ensure optimal focus by the image capture device on the image that arrives from the direction of the aspheric optical structure.

Fig. 4 is a schematic description of a possible design of the aspheric optical lens (18) designed for coverage of a first scene (19) comprising a 360 degrees panoramic surroundings and a second scene (20) which is at least partially above the first scene. The aspheric optical structure comprises a single optical element which is an aspheric optical block (18). The aspheric optical block (18) comprises a transparent perimeter surface (27), a transparent upper surface (32), a transparent lower convex surface (21), a transparent circular surface (22) located at the center of the transparent lower convex

surface (21) and a transparent area (23) located at the center of the transparent upper surface (32).

The lower convex surface (21) is coated with reflective material from its exterior, designed to reflect rays, which originate at a 360 degrees surroundings, towards the upper surface (32). The upper surface (32) is coated with reflective material from its exterior, designed to reflect rays, which arrive from the direction of the lower convex surface (21), towards the transparent circular surface (22) located at the center of the lower surface (21) and from there to an image capture device (not shown) located at the concave side of the optical lens (18). It is stressed that the lower convex surface (21) is not coated entirely with reflective material and a circular transparent surface (22) is maintained at the center of the lower surface (21). It is further stressed that the upper surface (32) is not coated entirely with reflective material and a transparent area (23) is maintained in the upper surface (32), allowing light rays from a second scene (20) to penetrate the optical block (18) through said transparent area (23) and exit through said circular transparent surface (22). The geometry of the transparent area (23) may be different than that of the upper surface (32) and its shape may be designed to control the size of the upper sector (20) which is covered. It is also possible to make use of an additional optical structure (24) which is placed above the transparent area (23) and coaxially with the vertical axis of symmetry of the aspheric optical block (18). The optical structure (24) is preferably fabricated in a size that enables exact placement and fastening to the aspheric optical block (18). The additional optical structure (24), when properly designed, enables control

over the size and optical qualities of second scene (20) that is covered. The additional optical structure (24) may be comprised of several separate optical elements, however, for the purpose of brevity and clarity, it is referred to as a single element.

Reference is now made to the optical paths of light rays originating at the two scenes, which are covered by the optical block (18).

A first light ray (25) represents a group of light rays originating at the panoramic scene (19). A second light ray (26) represents a group of light rays originating at the second scene (20). The first light ray (25) hits the perimeter refractive surface (27) at a first point (28), and penetrates the optical block (18). The ray (25) then travels through the optical block (18) and hits the lower surface (21) at a second point (29), where it is reflected towards the upper surface (32). The reflection is achieved due to the existence of the reflective material on the desired area on the exterior of the transparent lower surface (21). The ray (25) then hits the upper surface (32) at a third point (30) and it is then reflected towards the circular transparent surface (22) hitting it at a fourth point (31) where it is refracted and exits the lens (18).

Similar paths can be described in reference to and any other light ray that is within the first scene (19). The second light ray (26) hits the additional optical structure (24) and travels through it. The ray (26) may be refracted several times, should the additional optical structure (24) be comprised of several separate optical elements. After exiting the additional optical structure (24), the ray (26) travels towards the transparent area (23). The ray (26) then hits the transparent area (23), where it is refracted and enters into the

optical block (18). The ray then travels through the optical block (18) until it hits the transparent circular surface (22) where it is refracted again and exits the optical block (18). As previously indicated, the additional optical structure (24) is designed to control the size and optical qualities of the second scene that will be covered. The additional optical structure (24) may be comprised of several separate optical elements to compensate any aberrations that may be generated along the optical path of light rays that originate at the second scene. It is stressed that the optical path within the additional optical structure (24) is to be considered only if such optical structure (24) is indeed implemented. It is stressed that the transparent area (23) may be fabricated in several methods. A first method is forming only a partial reflective coating over the transparent upper surface (32), leaving an area around the vertical axis of symmetry of the aspheric optical block uncoated, thus allowing light rays to penetrate the aspheric optical block. Another way of fabrication of the transparent area (23) is to produce a refractive surface with different geometry than that of the transparent upper surface by imposing a different curvature on an area around the vertical axis of symmetry of the aspheric optical block. This will cause the transparent area to have different refraction qualities. A third method is by forming a hole along the vertical axis of symmetry of the aspheric optical block, at a certain diameter, to allow light rays to pass freely through the said hole. However, it should be appreciated that each method will necessitate a different optical design.

The combination of an image capture device with the optical block (18) to achieve capture of the two scenes (simultaneously) may be performed as demonstrated in reference to figure 2.

Referring to the optical structures demonstrated in figures 1-2 and 4, it is stressed that the design of all the curves of the optical block is performed while considering the mutual effects that the surfaces will have on the distortions or aberrations of the beams, thus proper design of the optical block and its curves would consider using the surfaces themselves to compensate each other's optical distortions to achieve, at the end, an image of minimal aberrations. Therefore, the schematic curves demonstrated in the said figures may be implemented in various ways and are subject to precise optical design. In any case, the description provided hereby should not be considered as limiting the scope of the present invention.

All the above description of preferred embodiments has been provided only for the purpose of illustration, and is not intended to limit the invention in any way. As will be appreciated by the skilled person, many variations and modifications are possible, without exceeding the scope of the invention.

Claims

1. A panoramic imaging assembly comprising an aspheric optical block, said aspheric optical block having:

   a) a vertical axis of symmetry;

   b) a transparent upper surface, completely coated with reflective material from its exterior;

   c) a transparent perimeter surface;

   d) a transparent lower convex surface coated with reflective material from its exterior;

   e) a transparent circular surface maintained in said lower convex surface around said vertical axis of symmetry.

   wherein light from a 360 degrees panoramic scene is refracted by said transparent perimeter surface, is then reflected by said lower convex surface towards said upper surface, then reflected by said upper surface towards said transparent circular surface and then refracted by said transparent circular surface and exits said optical block.

2. A panoramic imaging assembly according to claim 1, further comprising an image capture device, directed toward said transparent circular surface of said aspheric optical block, having its optical axis coinciding with said vertical axis of symmetry of said aspheric optical block.

3. A panoramic imaging assembly according to claim 2, wherein said image capture device comprises a focusing lens.

4. A panoramic imaging assembly according to claim 2, further comprising a connector located between said optical block and the said image capture device, having a first edge and a second edge, wherein optical transparency exists between said first edge and said second edge, allowing light penetrating from said first edge to reach and exit through said second edge essentially without distortion.

5. A panoramic imaging assembly according to claim 4, wherein said connector is cylindrical in shape.

6. A panoramic imaging assembly according to claim 4, wherein said first edge of said connector is designed to be connected to said aspheric optical block.

7. A panoramic imaging assembly according to claim 4, wherein said second edge of said connector is designed to be mounted on and connected to said image capture device.

8. A panoramic imaging assembly according to claim 4, wherein the distance between said first edge of said connector and said second edge of said connector is designed to

allow optimal focus by the said image capture device on the image reflected by said aspheric optical block.

9. A panoramic imaging assembly according to claim 4, wherein said connector is fabricated together with said aspheric optical block to form a single monolithic optical structure.

10. A panoramic imaging assembly according to claim 2, further comprising an optical lens designed to correct astigmatism in the image that is reflected by said aspheric optical block, said optical lens is located around said vertical axis of symmetry and between said image capture device and said aspheric optical block.

11. A panoramic imaging assembly according to claim 1, wherein said transparent circular surface is fabricated as a refractive lens, having a different geometry than the said lower convex surface.

12. A nearly spherical view imaging assembly comprising an aspheric optical block, said aspheric optical block having:

a) a vertical axis of symmetry;

b) a transparent upper surface, coated with reflective material from its exterior;

c) a transparent area maintained in said upper surface around said vertical axis of

symmetry.

d) a transparent perimeter surface;

e) a transparent lower convex surface coated with reflective material from its exterior;

f) a transparent circular surface maintained in said lower convex surface around said vertical axis of symmetry.

wherein light from a 360 degrees panoramic scene is refracted by said transparent perimeter surface, is then reflected by said lower convex surface towards said upper surface, then reflected by said upper surface towards said transparent circular surface and then refracted by said transparent circular surface and exits said optical block, and light from a second scene, located at least partially above said 360 degrees panoramic scene, is refracted by said transparent area, then refracted by said transparent circular surface and exits said aspheric optical block.

13. A nearly spherical view imaging assembly according to claim 12, wherein said transparent area is fabricated as a refractive lens, having a different geometry than the said upper surface.

14. A nearly spherical view imaging assembly according to claim 12, wherein said transparent area of said aspheric optical block is fabricated as a hole around said

vertical axis of symmetry extending from said upper surface to said transparent circular surface.

15. A nearly spherical view imaging assembly according to claim 12, further comprising an optical structure located coaxially with said vertical axis of symmetry of said aspheric optical block and above said transparent area, said optical structure being designed to refract light from a scene located at least partially above said 360 degrees panoramic scene, toward said transparent area.

16. A nearly spherical view imaging assembly according to claim 15, wherein said optical structure comprises a plurality of optical elements.

17. A nearly spherical view imaging assembly according to claim 12, further comprising an image capture device, directed towards said transparent circular surface of said aspheric optical block, having its optical axis coinciding with said vertical axis of symmetry of said aspheric optical block.

18. A nearly spherical view imaging assembly according to claim 17, wherein said image capture device comprises a focusing lens.

19. A nearly spherical view imaging assembly according to claim 17, further comprising a connector located between said aspheric optical block and said image capture device, having a first edge and a second edge, wherein optical transparency exists between said first edge and said second edge, allowing light penetrating from said first edge to reach and exit through said second edge essentially without distortion.

20. A nearly spherical view imaging assembly according to claim 19, wherein said connector is cylindrical in shape.

21. A nearly spherical view imaging assembly according to claim 19, wherein said first edge of said connector is designed to be connected to said aspheric optical block.

22. A nearly spherical view imaging assembly according to claim 19, wherein said second edge of said connector is designed to be mounted on and connected to said image capture device.

23. A nearly spherical imaging assembly according to claim 19, wherein the distance between said first edge of said connector and said second edge of said connector is designed to allow optimal focus by the said image capture device on the image that arrives from the direction of said aspheric optical block.

24. A nearly spherical imaging assembly according to claim 19, wherein said connector is fabricated together with said aspheric optical block to form a single monolithic optical structure.

25. A nearly spherical view imaging assembly according to claim 17, further comprising an optical lens designed to correct astigmatism in the image that is reflected by said aspheric optical block, said optical lens is located around said vertical axis of symmetry and between said image capture device and said aspheric optical block.

26. A nearly spherical view imaging assembly according to claim 12, wherein said transparent circular surface is fabricated as a refractive lens, having a different geometry than the said lower convex surface.

O.D.F. Optronics Ltd.

Four Sheets of Drawings
Sheet No. 1

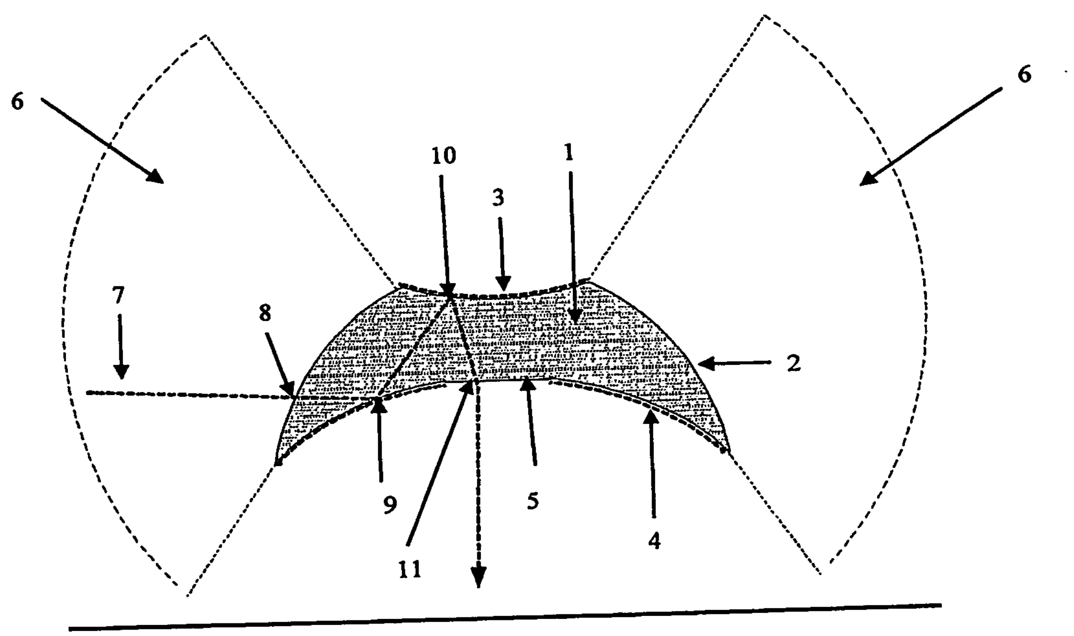

Fig. 1

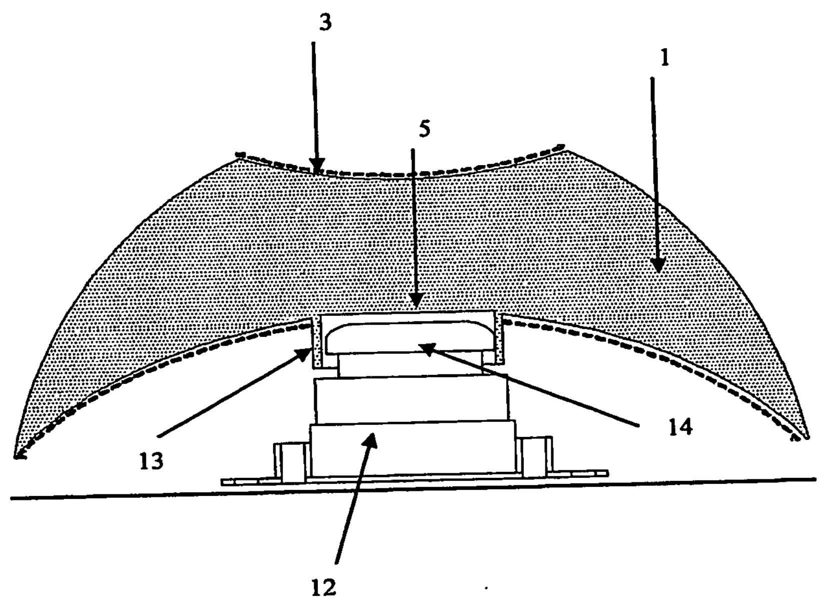

Fig. 2

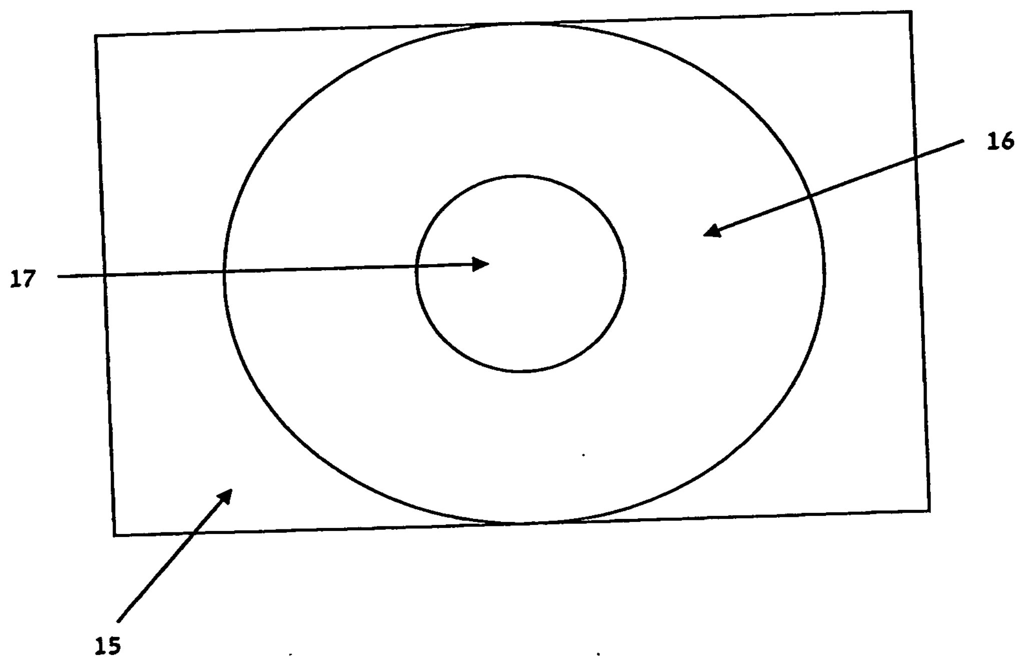

Fig. 3

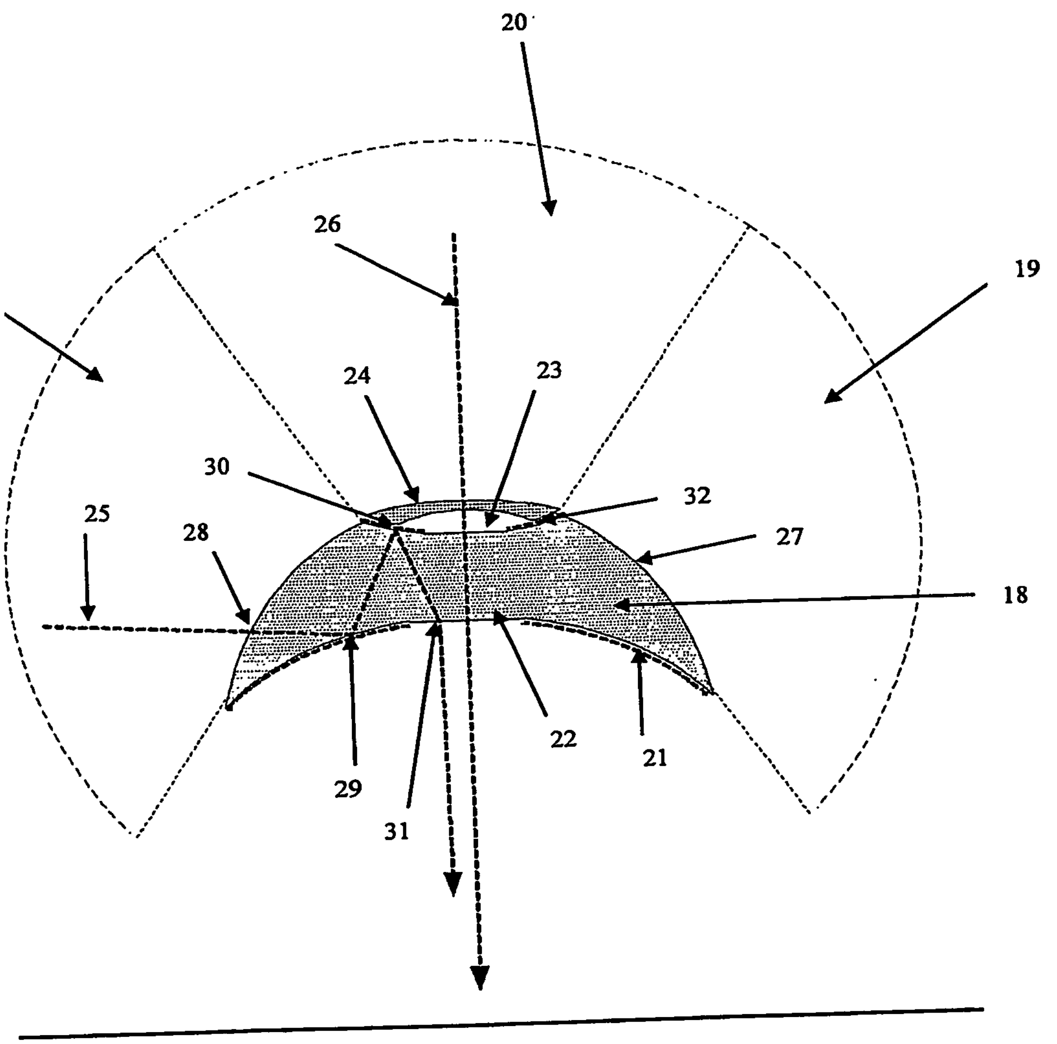

Fig. 4